



# **SOUNDSCAPE AS A HERITAGE – HOW IMPORTANT IS IT? EVALUATION OF SOUNDSCAPE IN CHINA AND CROATIA**

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## **Abstract**

This paper discusses the ideas that led to the realization of a bilateral Chinese-Croatian project focused on the soundscape of cultural and natural heritage sites in China and Croatia, and presents the research methodology utilized during the project. The main motivation for the research are the notable geographical, historical and cultural differences between the two countries. The research goal is to investigate whether the soundscape perception is influenced by these differences, in order to understand the importance of sounds in preserving the authenticity of a heritage place and to protect it from deterioration. The soundscape approach is used in the research as an investigative tool. Extensive listening tests will be made, in which the listeners shall evaluate the soundscapes of similar environments in both countries. The aim is to determine how people react to various sounds of their own heritage, and, more importantly, how they react to the heritage sounds from another country. The sound samples, already recorded in Ambisonics and binaural format at the chosen heritage sites, will be reproduced to the listeners. In addition to audio recordings, video stimuli taken at the heritage sites shall provide a realistic listening experience for the listeners. To compare the information obtained from the laboratory listening tests with the data already obtained in field surveys, the questionnaires given to the visitors of the heritage sites during in-situ examinations shall also be used in laboratory listening tests.

**Keywords:** heritage, historical and cultural differences, soundscape perception.

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## **1 Introduction**

With the rise of technological era, new sounds and elevated noise levels have been introduced into the environment. The field of environmental noise control gained much significance due to increasing awareness on the negative effects of exposure to noise. Noise abatement procedures, practice and legislation have been developed. This seems to be a straightforward approach similar to the protection against other harmful emissions, but people's concern with environmental sounds has soon outgrown



the mere concern with noise. The soundscape research addresses the perception of a sound environment and it can be understood as the auditory equivalence to the visual “landscape”.

This is especially pronounced in heritage places where the same sound environments have existed throughout centuries. To explore that, this research will focus on heritage of China and Croatia by investigating how the sound environment (soundscape) is perceived by people from both nations.

The term soundscape denotes a sonic environment, formed within a context, as it is understood and perceived by people [1]. It involves diverse fields of practice, diverse approaches and multidisciplinary interests. Today, soundscape is one of the main areas of acoustics, complemented with architecture, urban planning, psychology, sociology and many other disciplines as integral parts of multidisciplinary soundscape research throughout the world.

The improvement of soundscape quality is the ultimate goal of soundscape research and many studies evaluate the perception of a soundscape at a given location before and after certain adaptation work has been done. However, an equally important aspect of soundscape addresses people's expectations about the sounds that are appropriate and desired in specific places, typically locations which are considered as heritage places.

The project is focused on soundscapes of different cultural and natural heritage sites in China and Croatia. The spatial, historical and cultural differences between the two countries are notable. This research shall investigate whether people's perception of the sounds in the respective heritage also reflects these differences. This is very important in order to understand the importance of sounds in preserving the authenticity of a heritage place and to protect it from deterioration, similar to protecting a historical place from architectural or other changes.

For this reason, soundscape approach is used as a tool for investigation, with listeners evaluating the soundscapes of well-known environments from both countries, China and Croatia. The research task is to find out how people react to the various sounds of their heritage, and the importance of soundscape regarding the protection of the cultural and natural heritage. To do this, the researchers have utilized narrative interviews and soundwalks to investigate the soundscape experience. Additionally, sounds in chosen heritage sites were recorded and will be reproduced back to the listeners in laboratory listening tests.

To carry out the investigations required to complete the project, the Croatian group from the University of Zagreb has joined with the research group from Harbin Institute of Technology, School of Architecture. The team formed in this way represents a blend of acousticians and architects working on the same issues, each of them contributing with their own unique point of view.

Previous work of the research group at University of Zagreb was partly related to cultural sites in Croatia, namely the research of the Sea Organ as a unique soundscape installation in the city of Zadar. The research described in [2] investigated acoustical properties of this location and the way it was perceived by tourists and residents. Other previously conducted research [3, 4] has found that cultural, educational and other differences between people influence the perception of soundscape. In a similar way, the project will investigate this perception, but with the focus on soundscapes of heritage sites.

The intent of the project is to enhance the cooperation and better understanding between the two research groups. In accordance with the fundamentals of the soundscape principle, the results of the project should lead to a better understanding of heritage sites and their evaluation in terms of sound perception.

## 2 The chosen sites

The sites on which the investigations were made were chosen in a similar manner in both China and Croatia. The basic distinction was made between typical city sites and the ones found in the coastal regions of both countries. Specifically, three locations were chosen in a city, and another three in small resorts on the coast, giving six locations altogether in each country.

In continental cities, the following locations were chosen: one of the central squares in the city where a lot of people and traffic movement is expected, a smaller, more intimate square related to citizen activities that are not limited to just passing through, and one city park with vegetation and facilities related to leisure time.

In coastal cities, the following locations were chosen: a city square just at the coast, a public beach with a dedicated area for sunbathing and relaxing, and a quieter, less populated part of the beach in the city.

At each location, recordings were made twice, the first time in the morning or in the early afternoon, and the second time in late afternoon or evening when the activities of the people found in those locations generally change.

## 2.1 China

The chosen continental city for this study was Harbin, the capital of the northern Chinese province of Heilongjiang (population approx. 10 million). The chosen coastal city was Huludao, a prefecture-level city in southwestern Liaoning province (population approx. 2.8 million).

The survey and recording sites in Harbin were: Stalin park, Citizen square and General park (Figure 1). Recordings and surveys were conducted in Huludao in the following sites: in a square near the beach, in a populated part of the beach and in a less populated part of the beach (Figure 2).



Figure 1 – Investigated sites in Harbin: Stalin park (top left), Citizen square (top right) and General park (bottom).



Figure 2 – Investigated sites in Huludao: square near the beach (top left), populated part of the beach (top right) and less populated part of the beach (bottom).

## 2.2 Croatia

The chosen continental city for this study was Zagreb, the capital of Croatia (population approx. 800.000), and the chosen coastal city was Biograd na moru, a town located in the central part of the east Adriatic coast (population approx. 6.000).

The survey and recording sites in Zagreb were: Ban Jelacic square (main city square), Cvjetni square and Bundek park (Figure 3). Similar to China, recordings and surveys in Biograd na moru were conducted in the following sites: in a square near the coast, in a populated part of the beach and in a less populated part of the beach (Figure 4).



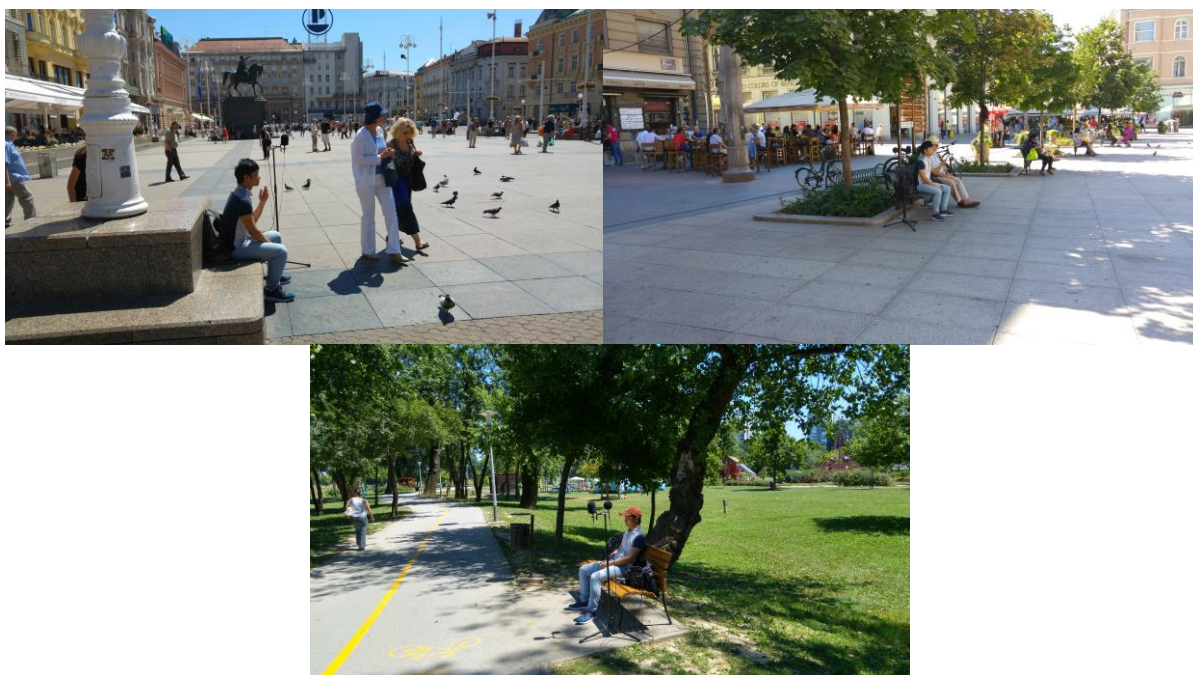


Figure 3 – Investigated sites in Zagreb: Ban Jelacic square (top left), Cvjetni square (top right) and Bundek park (bottom).

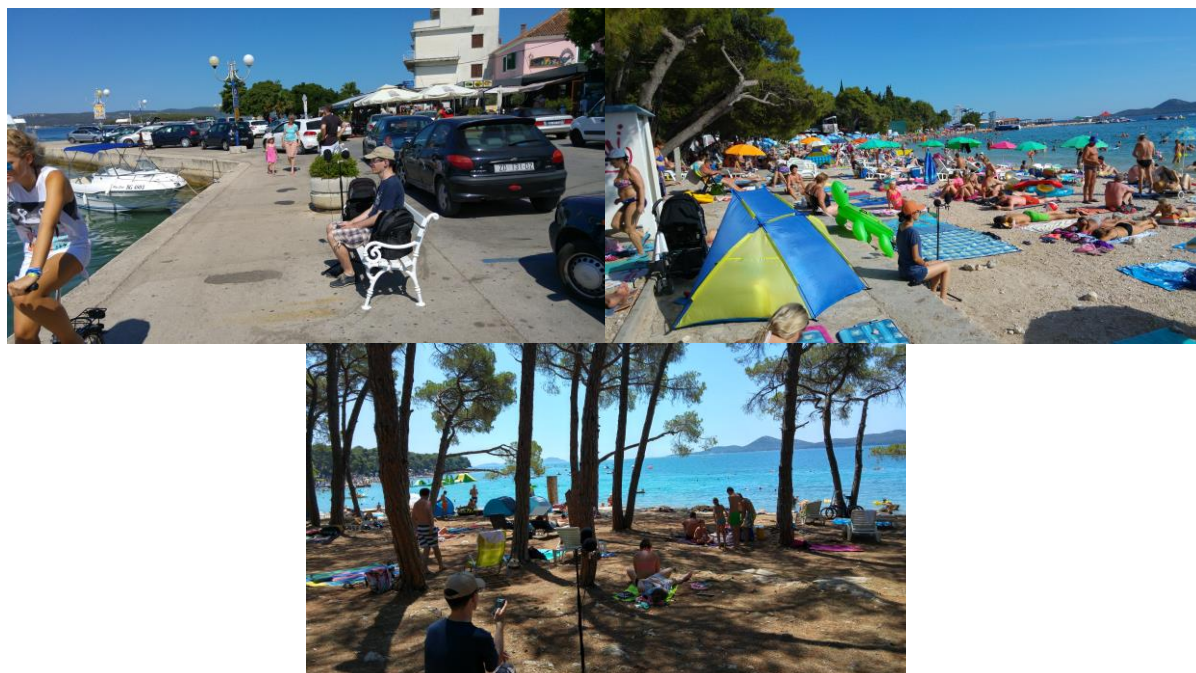


Figure 4 – Investigated sites in Biograd na moru: square near the beach (top left), populated part of the beach (top right) and less populated part of the beach (bottom).

### 3 Methodology

#### 3.1 Audio recordings of sound environments

To capture the sound environments on tested locations, samples of the overall sound image were taken in the form of audio recordings. The same recordings are used to obtain a set of single-number physical and psychoacoustical parameters used to describe the sound environments on tested locations in an objective manner. Spatial audio recording techniques were used to capture not only the content of the sound image, but also its spatial distribution. The techniques of choice were the binaural and the Ambisonics recording.

Binaural recordings were made using an M-AUDIO MicroTrack II two-channel recorder and a binaural microphone headset Sound Professionals SP-TFB-2, worn by a student volunteer. Ambisonics recordings were limited to four-channel, first-order recordings made using the Tetramic microphone and a Tascam DR-680 recorder.

All recordings were cut to the length of 5 minutes. This way, the sound of periodically occurring events can be captured. Two recordings were made at each location; one during daytime, and another one in the evening. The underlying assumption was that the sound environment would be different at different times of the day, assuming that the behaviour and the number of people at these locations changes as well.

#### 3.2 In-situ surveys

To capture the perception of the sound environments at tested locations in real time, the people found on-site were asked to become interviewees on a purely voluntary basis and to give their responses to a detailed questionnaire. The survey process on all locations was handled by master students and supervised by the authors.

Initially, inquiry about personal data was made, and the data was recorded on the gender, age, monthly earnings, city and/or country of origin, educational degree and profession of the interviewed person.

The person was then asked certain questions about the test location, namely, if they had been there before and how many times, what they were doing there, how long they had been there at the time of the interview, and how often do they visit the location. They were also asked about the type of dwelling they live in, their general health and their hearing. They were asked to state their opinion on the importance of quietness (tranquillity) in an environment, to make an assessment of the relation between the standard of living and sound environments of public spaces, and to state their opinion on the purpose of the public space under test.

After the initial set of questions, the interviewees were asked to evaluate their comfort level at the test location regarding the sounds, light, temperature and humidity, wind, water (if any), colours, odours, traffic and people present. The responses were given on a five-point scale with the following verbal explanations: 'very dissatisfied', 'dissatisfied', 'neutral', 'satisfied' and 'very satisfied'. They were also asked to state their reasons for giving these particular responses. The interviewees were asked to evaluate the overall environment in terms of their satisfaction with it and the level of comfort they feel during their stay at the test location. The answers here were given on a nine-point scale ranging between 'dissatisfying – satisfying' and 'uncomfortable – comfortable' with no additional verbal explanations.

The analysis of the sound environment was made with the interviewees evaluating the presence and/or the dominance level of specific types of sounds, namely, natural sounds such as water, wind or animals, technological sounds such as construction noise, but also music, small electronics or car horns, and sounds made by people, e.g. talking, walking, selling something, and the sounds made by



children. The five-point scale was used with the following verbal explanations: ‘do not hear at all’, ‘a little’, ‘moderately’, ‘a lot’ and ‘dominates completely’.

Finally, the interviewees were asked to describe their perception of the sound environment. The pleasant-eventfulness plane was used, defined by the semantic differential pairs ‘pleasant-unpleasant’ and ‘eventful-uneventful’, with additional control pairs ‘exciting-monotonous’ and ‘chaotic-calm’, all evaluated on a nine-point scale with no additional verbal explanations.

### 3.3 Laboratory listening tests

To examine the influence of cultural differences on the perception of a sound environment, listening experiments have to be performed in predefined and controllable laboratory conditions, with both Chinese and Croatian listeners participating in the tests, and with audio samples recorded in both countries reproduced to them. The parts of the tests in which the listeners listen to the sounds recorded in their own countries can be used to make the comparison between the perception of the sound environment recreated in the laboratory and the perception of the same sound environment experienced in-situ. However, the examination of the influence of cultural differences requires that the listeners from one country listen to the sounds recorded in the other country; therefore, the Chinese listeners have to listen to the sounds recorded in Croatia, and vice versa, and this is possible only in a laboratory experiment.

Both teams involved in the project possess the means and the necessary equipment to create a laboratory setup based on binaural reproduction over headphones, while only the Croatian team possesses a sound reproduction facility capable of handling Ambisonics recordings. Additionally, the binaural listening setup over headphones allows multiple listeners to take the test simultaneously, whereas the Ambisonics setup based on loudspeakers can handle only one listener at a time due to a very small “sweet spot”, within which the 3D sound field is recreated correctly. For these reasons, binaural recordings will be used in laboratory listening tests.

The reproduction of the sound recorded in a given location shall be complemented with visual stimuli, i.e. a representative photograph taken at that location, displayed on a large enough television screen or an image projecting device.

The reproduction is to be calibrated to yield the same sound pressure levels as the ones originally recorded in-situ. To make this possible, a 1 kHz 94 dB calibration signal has been recorded on a separate channel through a sound level meter, which was then used for making an additional monaural recording and for monitoring the sound pressure level.

To obtain meaningful results of statistical analyses, no less than 30 listeners shall be recruited to take part in the listening tests. Due to the quantity of the sound samples to be listened to and evaluated, several groups of listeners (at least 30 listeners each) will be required. Having in mind that both project teams come from institutions of higher education, the listeners will be foreseeably recruited from the student population. A small reward may be given to the listeners for taking part in the tests, but it is not obligatory.

The questionnaire to be used in laboratory listening tests will be derived from the one described in section 3.2. The questions related to the location itself and the level of comfort felt by the listeners are to be excluded. The composition and the perception of the sound environment shall be evaluated in the same way as in in-situ surveys.

### 3.4 Analysis of the results

Data analysis is to be performed in several stages. As mentioned before, all recordings will be analysed with a series of software-based analysers such as Psysound3, in order to obtain a set of single-number physical and psychoacoustical parameters that describe a sound environment in an objective manner. As in [2], all these parameters will be divided into four groups to evaluate the



amount of acoustic energy, spectral properties, fluctuations and tonality of the overall sound image in a given environment.

The in-situ questionnaires and the questionnaires used in laboratory experiments will undergo a statistical analysis. The in-situ perception of real sound environments is to be compared with the perception of the same environments recreated in laboratory. The influence of cross-cultural differences on soundscape perception will be examined by comparing the laboratory evaluation results of Chinese and Croatian listeners for the locations in both China and Croatia.

Finally, the relationship will be examined between objective parameters extracted from recorded sounds and subjective evaluations obtained from laboratory and in-situ evaluations through correlation analysis.

## 4 Conclusions

The project presented in this paper is focused on evaluation of soundscape of heritage sites in China and Croatia and was granted through a direct bilateral agreement between the two countries. So far, all the samples of the investigated sound environments have been collected and in-situ subjective evaluations have been performed. The work on the project is still ongoing and interesting results are expected to surface from subjective evaluations and objective analysis of recorded sample sounds of sound environments in heritage sites. Due to cultural differences that undoubtedly exist between the Chinese and Croatian people, a reasonable expectation is that the typical sound environments in both countries will be perceived quite differently by natives and by people to whom the culture and the resulting sound environments are foreign. An opportunity arises to examine the difference in soundscape perception for real environments in contrast with the ones recreated in a laboratory. Objective analysis of recorded sounds allows the single-number physical and psychoacoustical parameters to be used as objective descriptors of a sound environment. The relationship between these descriptors and subjective evaluation is to be examined as well.

## Acknowledgements

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## References

- [1] Botteldooren, D.; Lavandier, C.; Preis, A.; Dubois, D.; Aspuru, I.; Guastavino, C.; Brown, L.; Nilsson, M.; Andringa, T.C. Understanding urban and natural soundscapes, *Proceedings of Forum Acusticum 2011*, Aalborg, June 27 – July 1, 2011, pp 2047-2052.
- [2] Jambrošić, K.; Horvat, M.; Domitrović, H. Assessment of urban soundscapes with the focus on an architectural installation with musical features, *Journal of Acoustical Society of America*, Vol 134 (1), 2013, pp 869-879.
- [3] Kang, J. *Urban sound environment*, Taylor & Francis, New York (USA), 1<sup>st</sup> Edition, 2007
- [4] COST Action TD0804: Soundscape of European Cities and Landscapes, 2009 – 2013



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